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EL997095652US

Upper Broadwall

Bosses

y

A

Port 1

Port 2

Lower Broadwall

x

y

x

A

A

z

(a) Section AA

(b) Exploded View

Waffle-Iron Waveguide Filter: (a) view looking into port 2, (b) exploded view.

FIG. 1

14   14A   14B   4

13

D1   D3   D2

14C

14D

MAIN GROUND

10
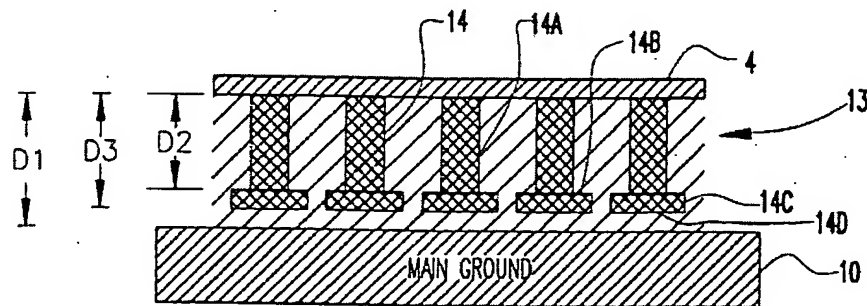
Examples of resonant vias from Riad's US patent 5,886,597.

FIG. 2

−LV

−CV
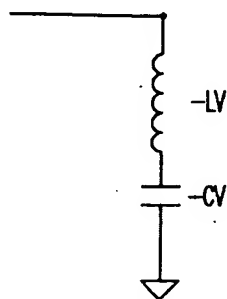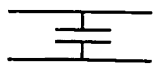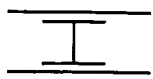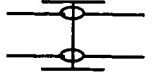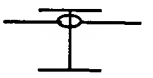
FIG. 3

|	Mechanically-Unbalanced	Mechanically-Balanced
Internal	Internal "T" US Pat. 5,886,597	Internal "double T" US Pat. 6,542,342 Internal "I"
External	External "T" US Pat. 5,886,597	External "I"
Hybrid		Hybrid "I"

Examples of resonant vias. Dielectric layers required for support are not shown.

FIG. 4

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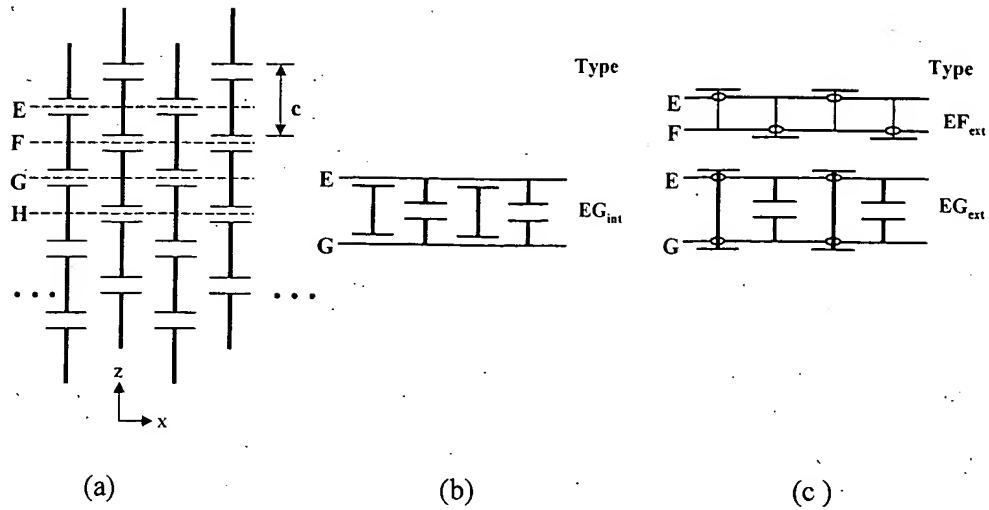Atty. Noel C. Gillespie
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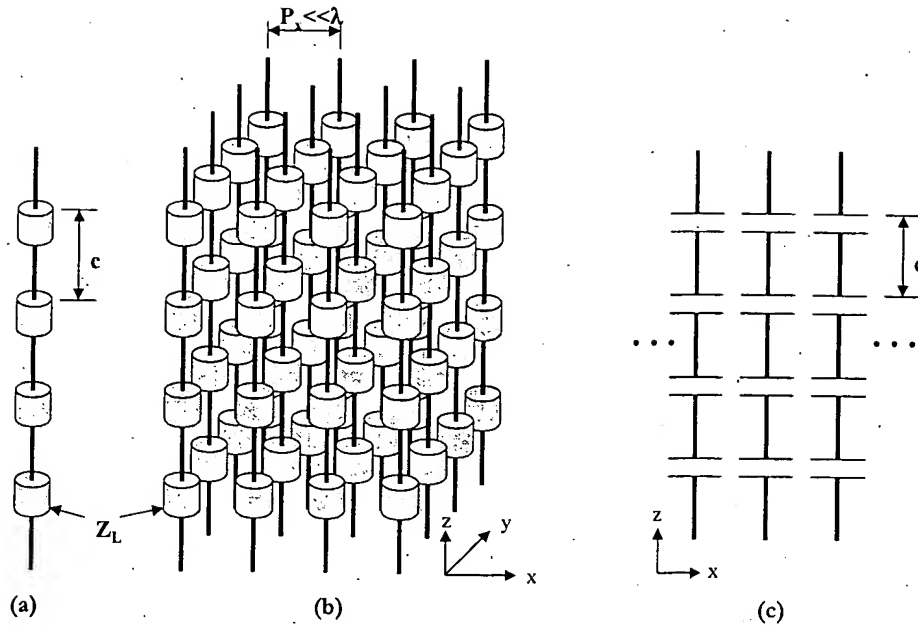
The starting point for the derivation of new inventions is the loaded wire media: (a) a single wire with uniform periodic series loads, (b) a rectangular array of loaded wires, (c) loads are now defined as parallel-plate capacitors.
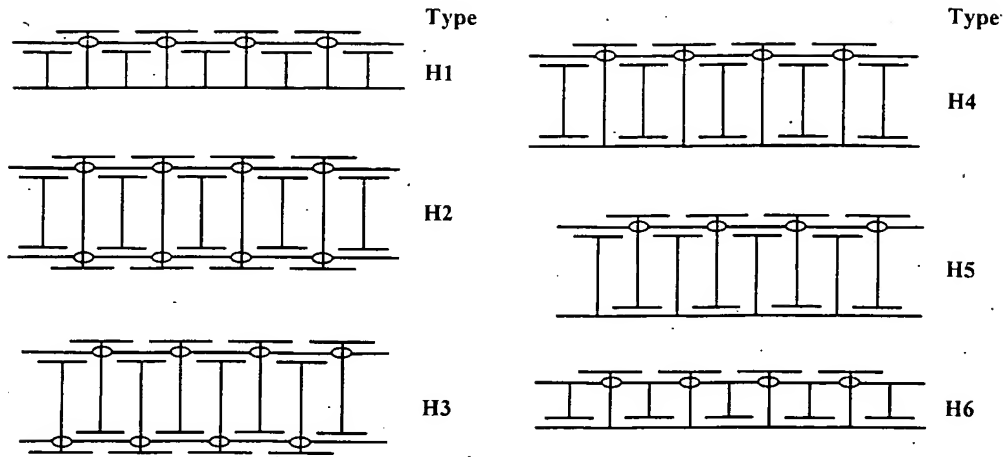
FIG. 5
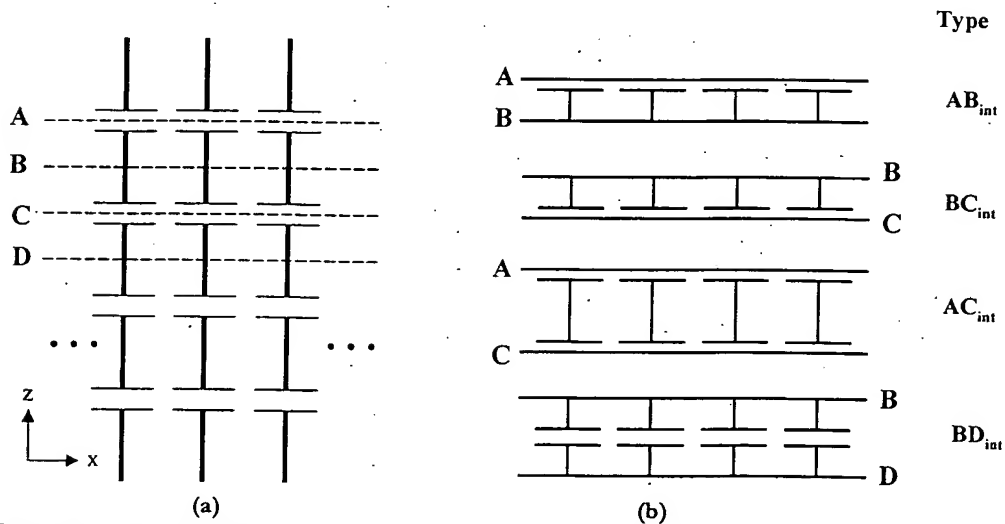
Exploit the planes of physical symmetry to obtain electromagnetically equivalent structures: (a) the infinite wire media, (b) PPW structures of finite height. The supporting dielectric structure is not shown.

FIG. 6

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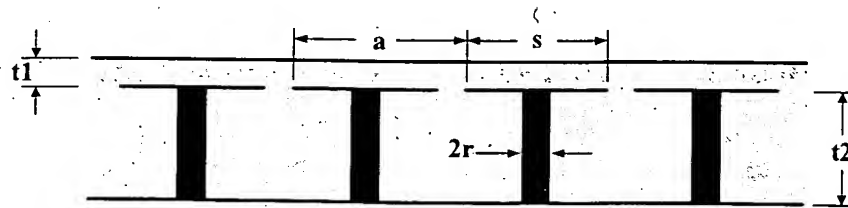(858) 720-2500
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Alternative embodiments of PPW stop band filters: (a) Capacitive-loaded infinite wire media, (b) a PPW filter of finite height using internal capacitors, (c) PPW filters of finite height using external capacitors. The supporting dielectric structure is not shown.

FIG. 7

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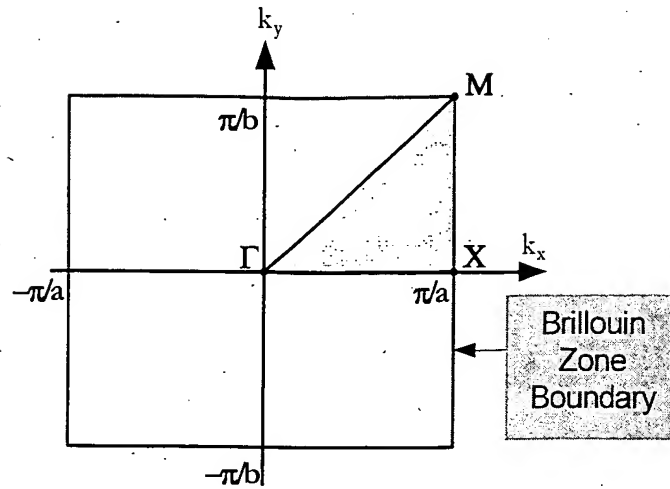
Type

H1

Type

H4

H2

H5

H3

H6

Hybrid embodiments include combined internal and external capacitive loads. Dielectric cores are omitted for clarity.

FIG. 8

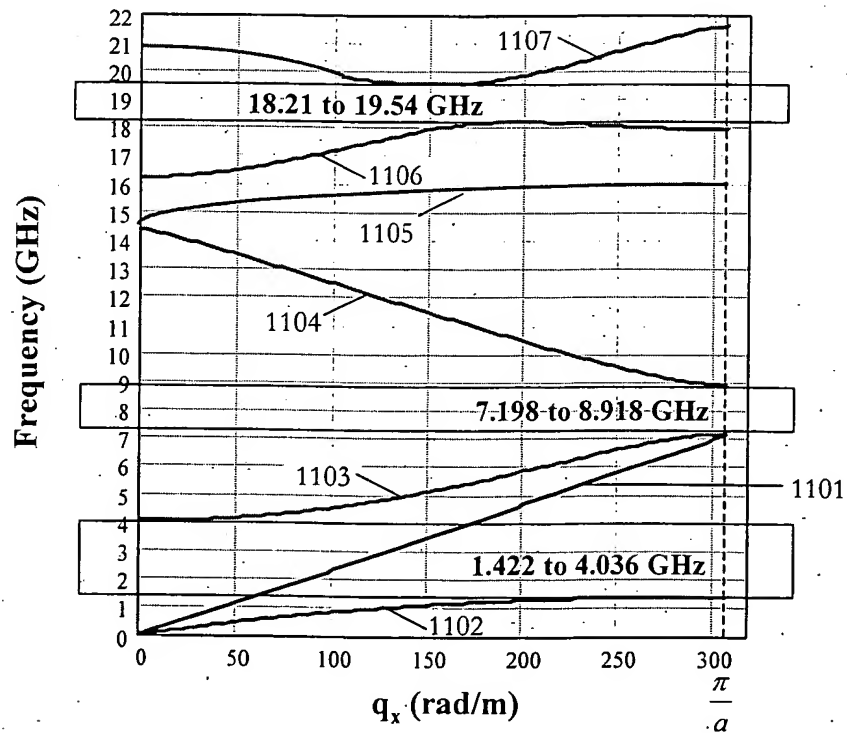Elevation view of a square lattice of internal T resonant vias.

FIG. 9

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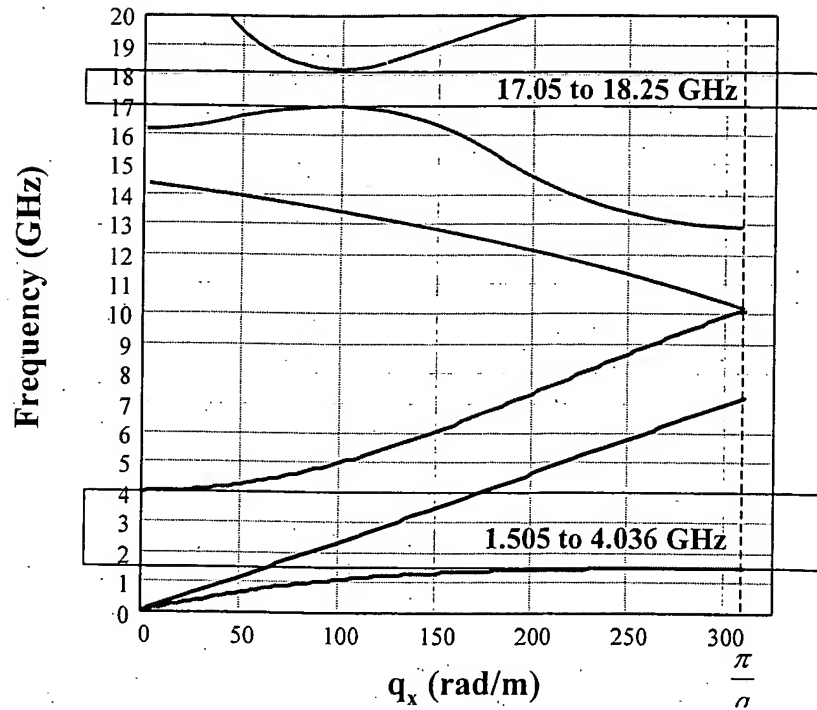Atty. Noel C. Gillespie
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Brillouin zone for a 2D periodic structure with a rectangular lattice of unit cell dimensions a x b in Cartesian coordinates.

FIG. 10

Dispersion diagram along the ΓX line for the capacitive-loaded wire media corresponding to the array of resonant vias shown in Figure 9. The stop bands are bracketed.

FIG. 11

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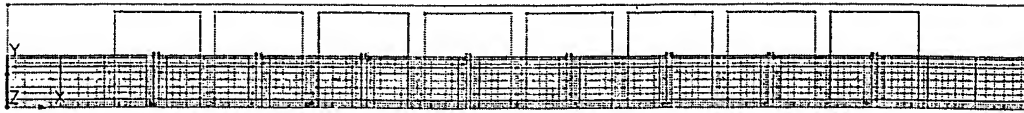Atty. Noel C. Gillespie
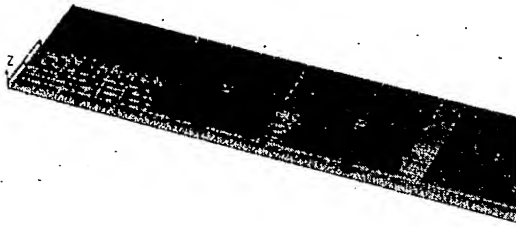(858) 720-2500
EL997095652US

Dispersion diagram along the ΓM line for the capacitive-loaded wire media corresponding to the array of resonant vias shown in Figure 9. The stop bands are bracketed.
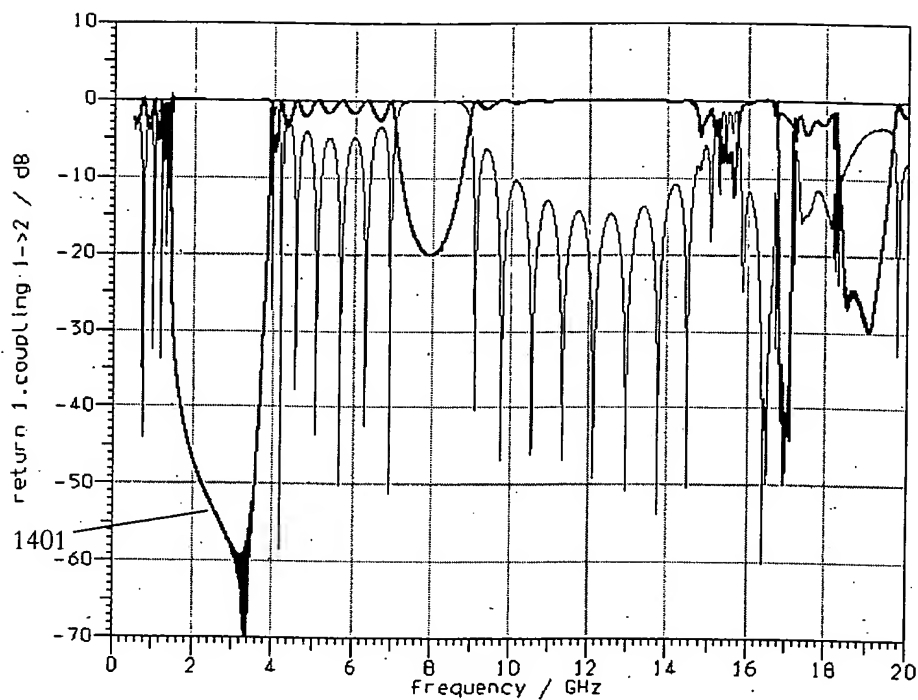
FIG. 12

(a)

(b)   (c)

Geometry for the simulation of the resonant via array shown in Figure 9: (a) plan view showing all 8 cascaded unit cells, (b) top view with upper plate hidden, (c) bottom view with the lower plate hidden.
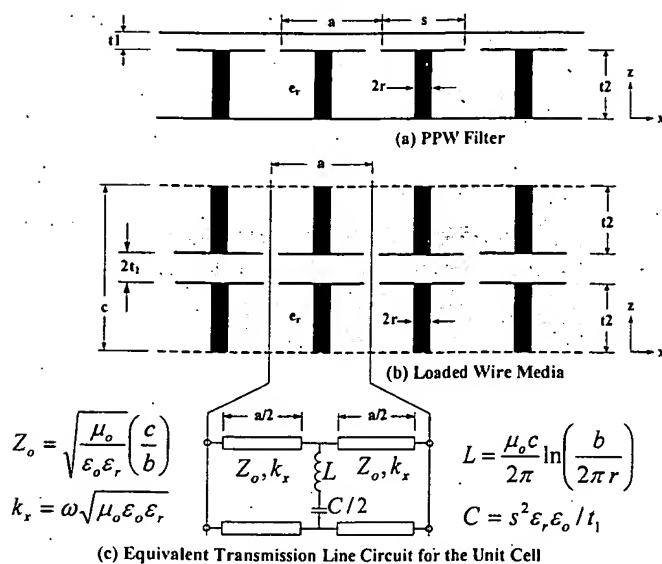
FIG. 13

Transmission response for a TEM mode propagating in the x direction through the stop band filter shown in Figure 9. A −10 - dB stop band is shown from 1.4 GHz to 3.9 GHz, a ratio of 2.78:1.

FIG. 14

Stopband	Microstripes		Eigenvalue Solution	
	Lower Band Edge	Upper Band Edge	Lower Band Edge	Upper Band Edge
	(GHz)	(GHz)	(GHz)	(GHz)
Fundamental	1.401	3.906	1.422	4.036
Secondary	7.07	8.85	7.198	8.918
Tertiary	18.28	19.62	18.21	19.54

Comparison of stop band frequencies for the PPW filter shown in Figure 9.

FIG. 15

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(a) PPW Filter

(b) Loaded Wire Media

$$Z_o = \sqrt{\frac{\mu_o}{\varepsilon_o \varepsilon_r}} \left(\frac{c}{b}\right)$$

$$k_x = \omega \sqrt{\mu_o \varepsilon_o \varepsilon_r}$$

$$L = \frac{\mu_o c}{2\pi} \ln\left(\frac{b}{2\pi r}\right)$$

$$C = s^2 \varepsilon_r \varepsilon_o / t_1$$

(c) Equivalent Transmission Line Circuit for the Unit Cell

At lower frequencies around the first stop band, wave propagation along a principal axis, such as the x-axis, can be modeled using a simple transmission line circuit model.
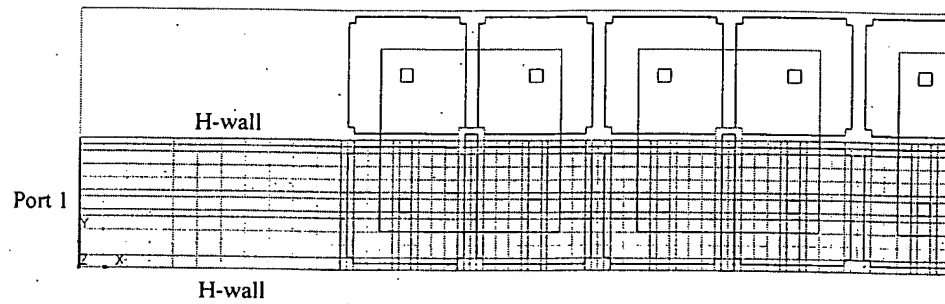
FIG. 16

	Internal Capacitors	External Capacitors	Hybrid (Internal & External Capacitors)
Mechanically-Unbalanced	I1	E1	H7 H8 H9
Mechanically-Balanced	I2 I3 I4 I5	E2 E3 E4 E5	H10 H11 H12
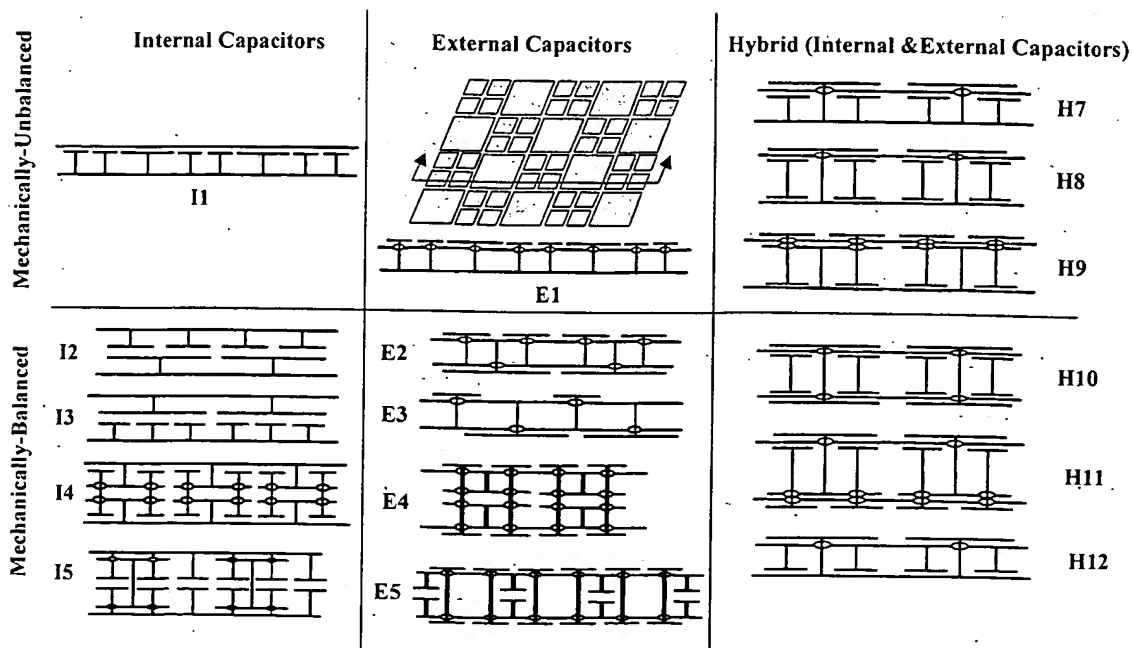
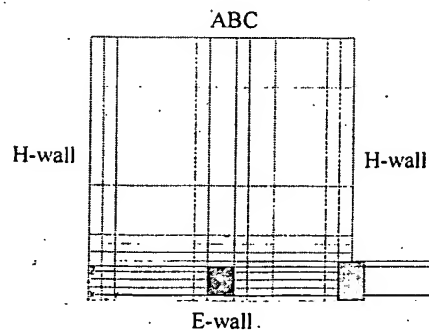Examples of resonant via arrays with commensurate periods. Each is a PPW stoop band filter.
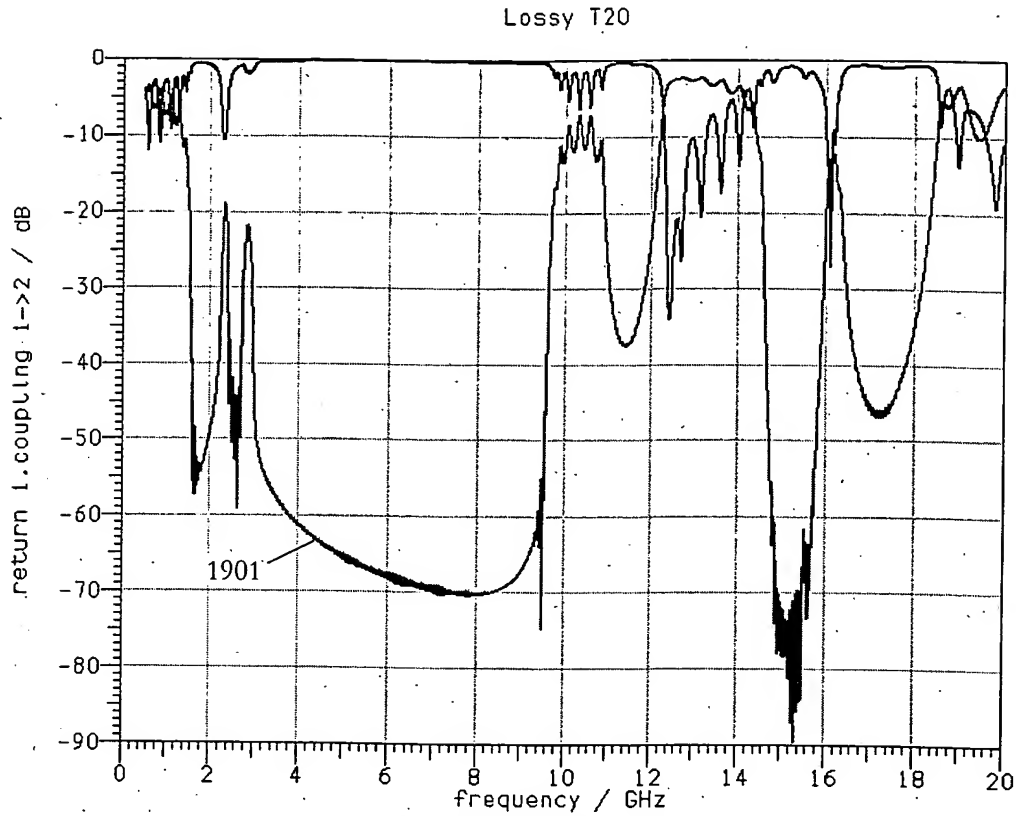
FIG. 17

(a)

(b)

(c)
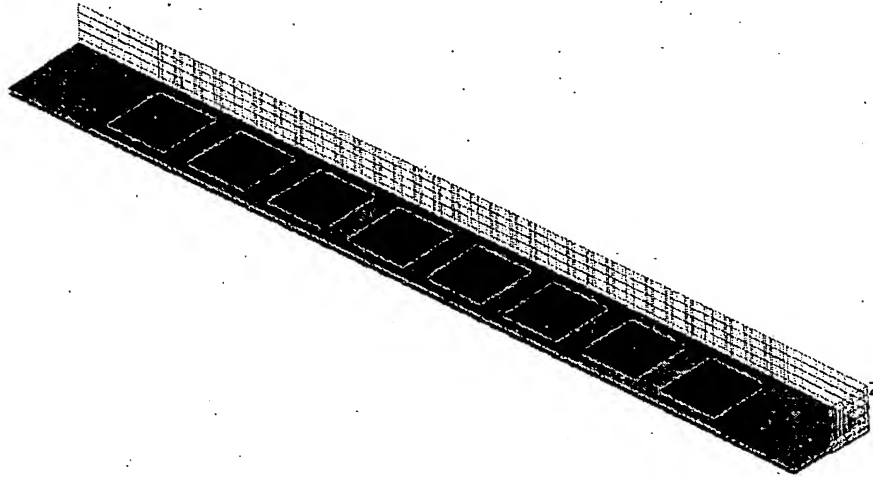
Geometry for the simulation of a commensurate period resonant via array of type H12: (a) perspective view showing all 8-cascaded unit cells, (b) plan view, (c) elevation view. Hidden are the dielectric cores in (a), (b) and (c).

FIG. 18

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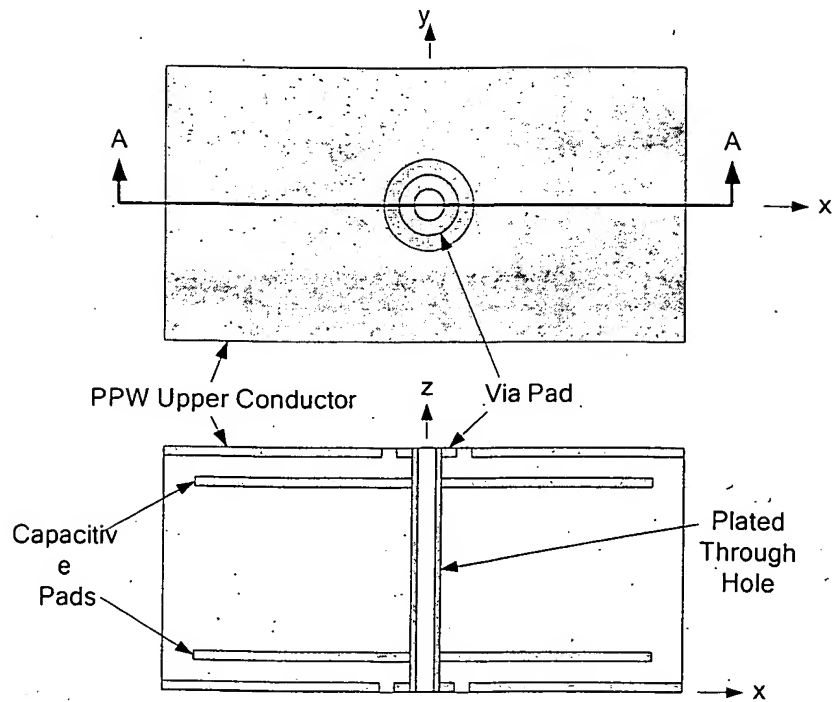(858) 720-2500
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Lossy T20

Transmission response (1901) for a TEM mode propagating in the x direction through the stop band filter shown in Figure 18. A –10 dB stop band is shown from 1.33 GHz to 10.0 GHz, a 7.5:1 ratio.

FIG. 19
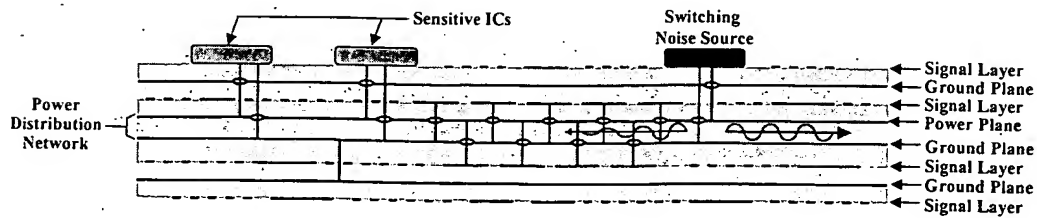
Stop band filter embodiment EF$_{ext}$ is well suited for integration into existing PWB designs since it requires neither additional metal layers nor any additional thickness.
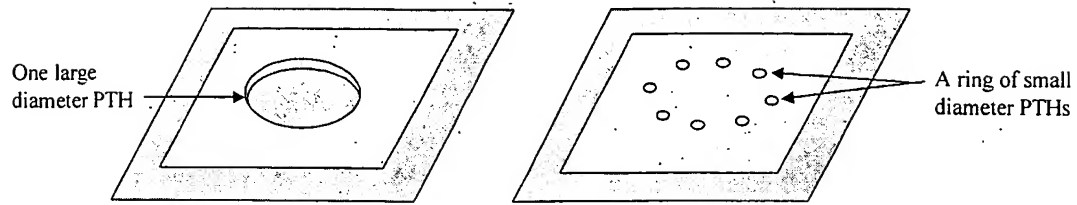
FIG. 20

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Plated through holes may be used in the fabrication of resonant vias as illustrated here for an internal I resonant via.
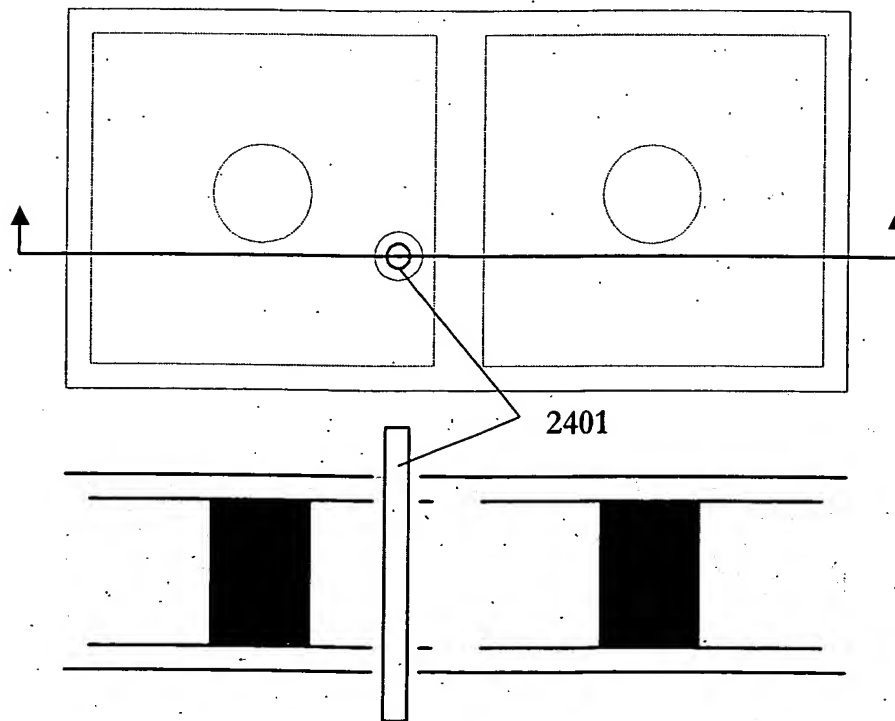
FIG. 21

Examples of fundamental resonant cluster via types consisting of two or more vias connected in parallel.. Dielectric layers required for support are not shown.

FIG. 22

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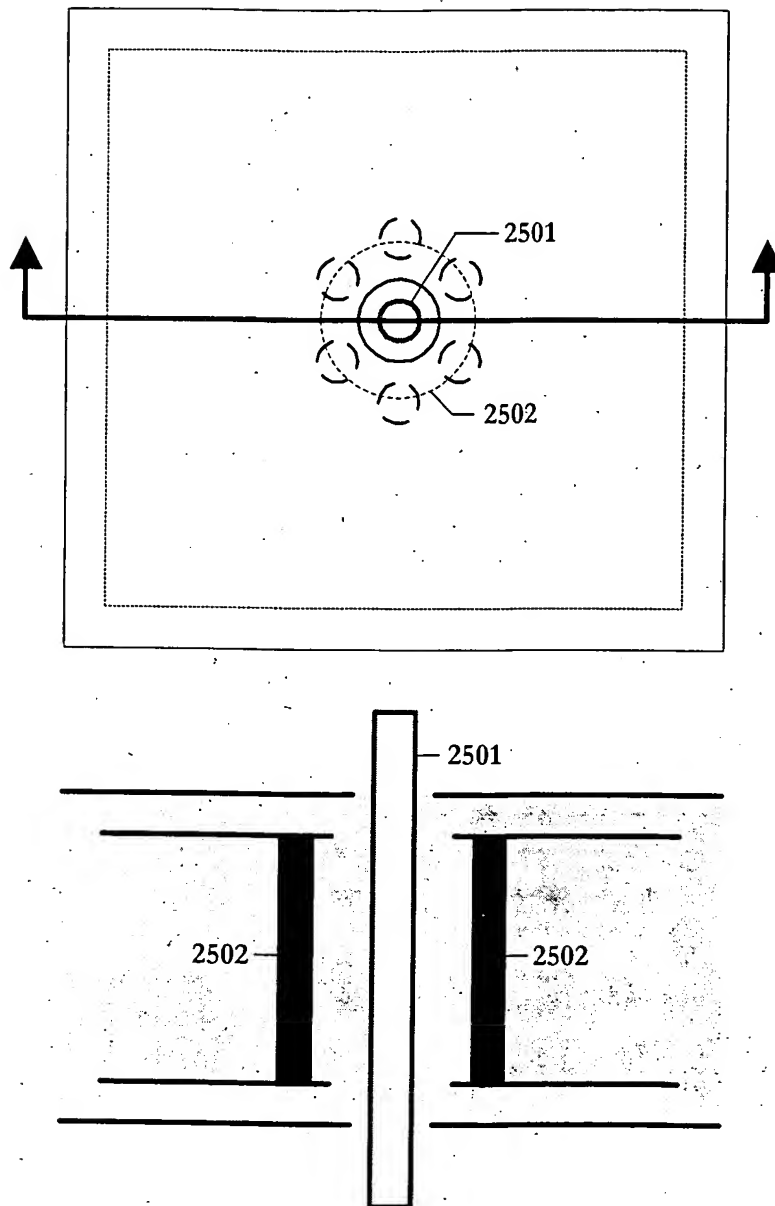One large
diameter PTH

A ring of small
diameter PTHs

Comparison of effective parallel-plate areas available for one large diameter via compared to an electrically equivalent cluster via comprising a ring of 8 smaller diameter vias.
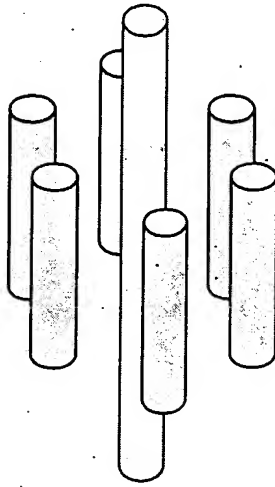
FIG. 23

2401

Pair of resonant vias showing signal via passing through the PPW.

FIG. 24

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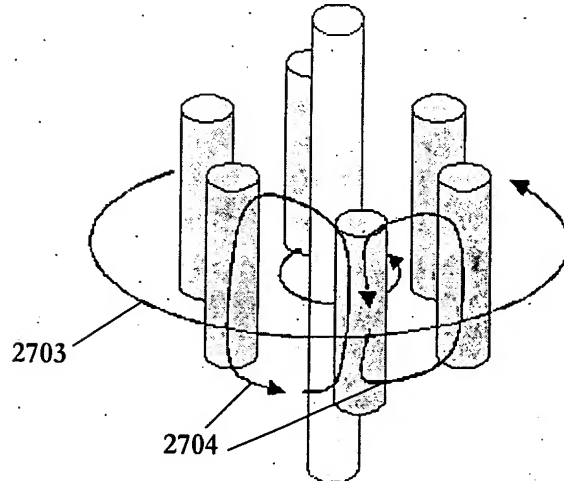(858) 720-2500
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Plan and elevation cross-sections of exemplary cluster via with interior signal via.

FIG. 25

Cluster via with interior signal via as in FIG. 25.

FIG. 26

2703

2704

Faraday cage formed by cluster of vias as in FIG 24.

FIG. 27